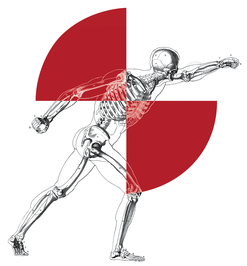

Injury Patterns of Elderly Occupants Involved in Side Crashes

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INTRODUCTION

- It is estimated that 50 million people over the age of 65 will be eligible to drive by 2020 [1]. Previous studies have shown that drivers 65 and older account for approximately 40% of crash involvement [1,2].
- Multiple injury risk factors for elderly occupants, such as lower bone density, geometry changes to the pelvis and ribs, and pre-existing medical conditions, may contribute to a higher risk of injury in motor vehicle crashes (MVCs), especially side crashes. Additionally, it has been suggested that these age-related risks differ by gender [3].
- The goal of this study is to identify the subset of the elderly population most at risk in MVCs and the body region most commonly injured in order to develop injury criteria for elderly occupants in side impact crashes.

METHODS

- Data was obtained from the National Automotive Sampling System Crashworthiness Data System (NASS CDS). The NASS CDS database represents a probability sample so each variable is weighted to produce national estimate numbers. Only data from the years 2000 – 2011 and only vehicle model years from 2000 onwards were included in the study.
- The occupants selected for this study consisted of drivers and right front passengers of passenger vehicles and light trucks or SUV's. Occupants were included if they were involved in a near side collision and excluded if they were under the age of sixteen years, pregnant, ejected from the vehicle, or involved in a rollover collision.
- Collision type was determined by the primary direction of force (PDOF) of the impact and the occupant's seat position, Figure 1. For this study the head, face, neck, thorax, abdomen, spine, upper limb, lower limb, ribs, and pelvis were analyzed for injury using SAS, a statistical analysis software. Each injury description was assigned a unique 7-digit Abbreviated Injury Scale (AIS) code that is described in Table 1.
- After analyzing the overall database, the occupant age range was narrowed to 60 – 90 years old. The resulting database was further analyzed to obtain information on the elderly population.

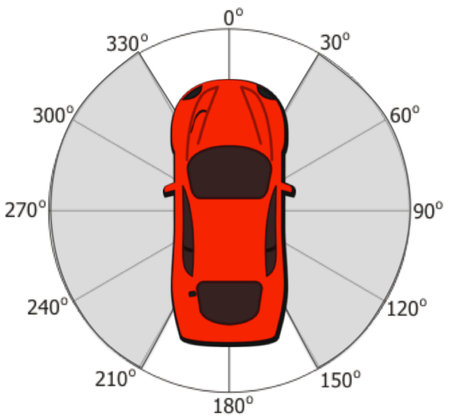

Figure 1. PDOF diagram

Body Region	1
Type of Structure	2
Specific Structure	3 4
Level	5 6
Severity of Injury	.7

Table 1. AIS Injury coding diagram

RESULTS & DISCUSSION

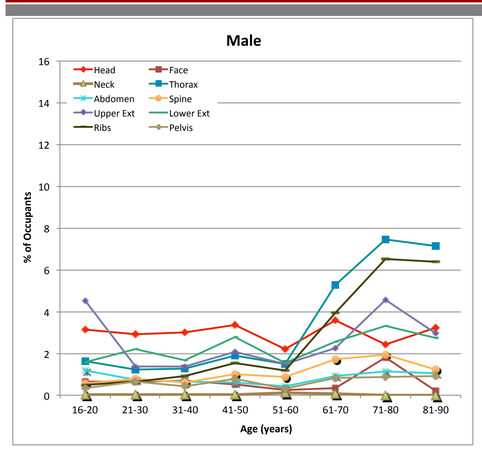

Figure 2a. Risk of AIS 2+ injury for all males

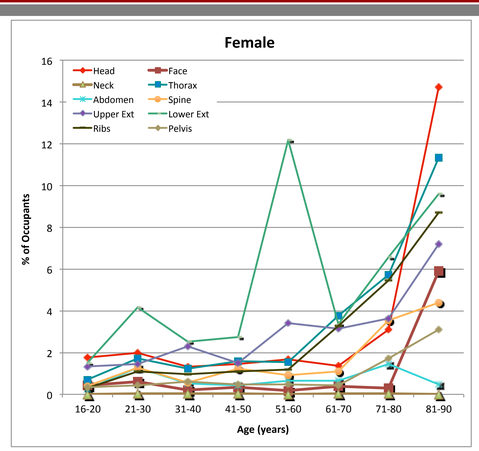

Figure 2b. Risk of AIS 2+ injury for all females

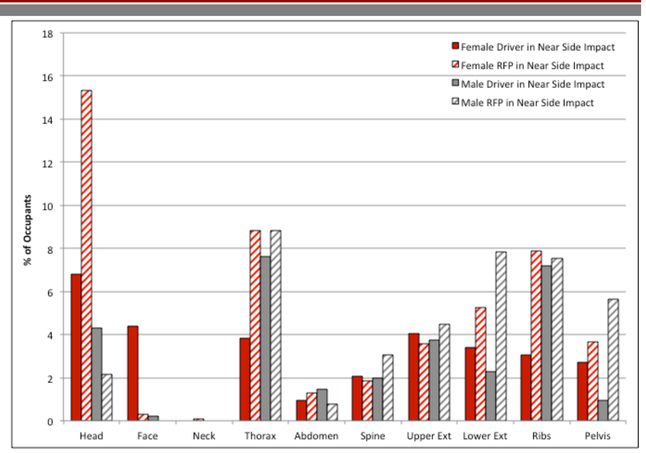

Figure 3. Risk of AIS 2+ injury (occupants 60-90 y.o.)

- Figure 2a shows the risk of AIS 2+ injury for all males above 16 years of age. The risk of injury to the thorax and ribs increases significantly after the age of 51-60 years while risk of injury to all other body regions either increases only slightly or stays constant.
- Figure 2b shows the risk of AIS 2+ injury for all females above 16 years of age. The risk of injury to all body regions increases significantly at the 61-70 year age group. Most noticeable are the increases in injury risk to the head, thorax, lower extremities, and ribs. Additionally, there is a large increase in the risk for lower extremity injury for the 51-60 year age group.
- Since each variable in the NASS CDS database is weighted to produce a national estimate, the outliers were checked against the raw data and it was determined that Figure 2b shows an exaggerated increase in risk of injury to the head as well as in injury to the lower extremities for the 51-60 year age group.
- These results show that the age group most at risk for increased injury includes adults 60 years and older. Further analysis was done on occupants between 60-90 years to see which body regions were most at risk.

	FEMALE DRIVER		FEMALE RFP		MALE DRIVER		MALE RFP	
	RAW	WEIGHTED	RAW	WEIGHTED	RAW	WEIGHTED	RAW	WEIGHTED
Head	34	5003	17	4334	41	4270	6	182
Face	4	3234	3	87	5	233	0	0
Neck	0	0	1	20	0	0	0	0
Thorax	39	2807	31	2499	52	7520	13	749
Abdomen	10	710	10	361	16	1450	3	65
Spine	14	1511	10	518	23	1956	3	261
Upper Ext	25	2972	13	1012	30	3688	4	382
Lower Ext	33	2489	24	1482	28	2235	9	665
Ribs	34	2241	28	2230	49	7120	11	640
Pelvis	27	2006	16	1033	17	926	4	478

Table 2. Comparison of raw and weighted data for male and female drivers and RFPs between 60-90 years

- Figure 3 shows the risk of AIS 2+ injury for both male and female drivers and RFPs between the ages of 60-90 years. Within this narrowed database, it can be seen that RFPs generally have a higher risk for injury than drivers. The body regions highlighted in this figure include the head, thorax, ribs, lower extremities, and pelvis.
- Table 2 compares the raw data collected for male and female drivers and RFPs and its weighted counterpart. All raw numbers do not necessarily get scaled to the same weighted number. For example, Table 2 shows that there are 17 recorded cases for head injuries for female RFPs as well as for pelvis injuries for male drivers. However, the head injuries for female RFPs are weighted to correspond to 4,334 cases while the pelvis injuries for male drivers are weighted to 926 cases.
- The risk for AIS 2+ injury is calculated from weighted data so it is necessary to be cautious of weighting factors that may skew results.

CONCLUSIONS

- The subset of the elderly population most at risk for injury includes female RFPs in near side collisions.
- After taking weighting factors into consideration, the body regions most at risk for injury include the thorax, ribs, lower extremities, and pelvis. Additional focus should be placed on the ribs and pelvis because of biomechanical changes that occur during aging.
- The results of this study will help direct post mortem human surrogate (PMHS) testing necessary to develop injury criteria for elderly occupants in side impact crashes.

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